



**Carnegie Mellon
Software Engineering Institute**

Interpreting Capability Maturity Model® Integration (CMMISM) for Operational Organizations

Brian P. Gallagher

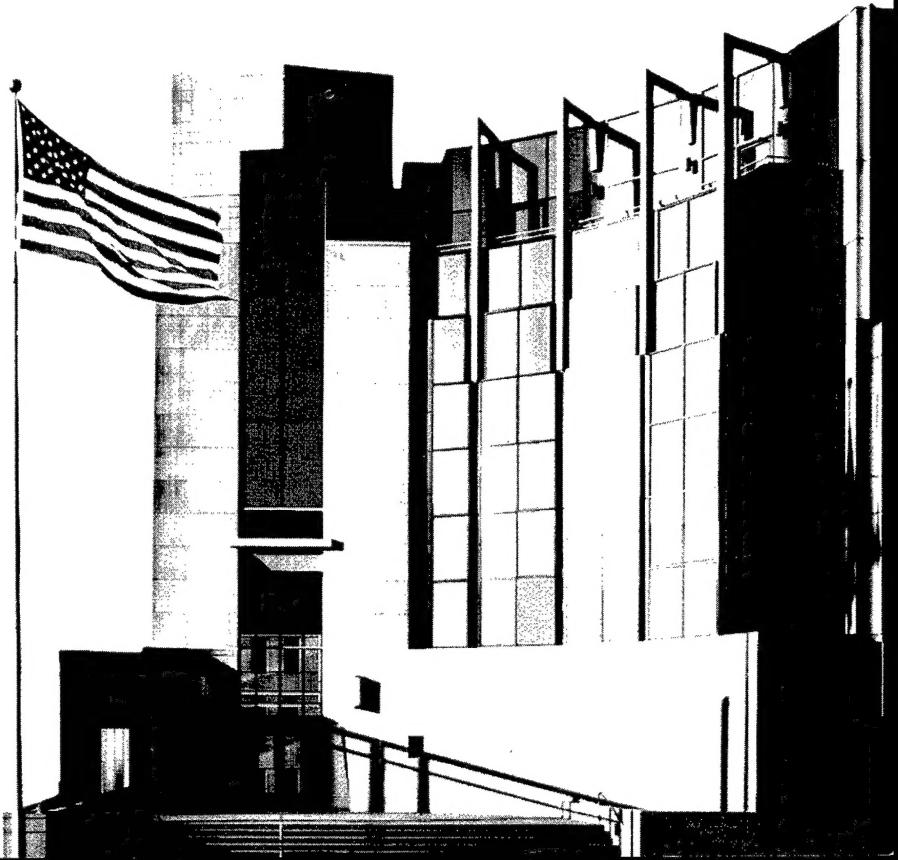
April 2002

Software Engineering

20020520 221

Unlimited distribution subject to the copyright.

Technical Note
CMU/SEI-2002-TN-006



Carnegie Mellon University does not discriminate and Carnegie Mellon University is required not to discriminate in admission, employment, or administration of its programs or activities on the basis of race, color, national origin, sex or handicap in violation of Title VI of the Civil Rights Act of 1964, Title IX of the Educational Amendments of 1972 and Section 504 of the Rehabilitation Act of 1973 or other federal, state, or local laws or executive orders.

In addition, Carnegie Mellon University does not discriminate in admission, employment or administration of its programs on the basis of religion, creed, ancestry, belief, age, veteran status, sexual orientation or in violation of federal, state, or local laws or executive orders. However, in the judgment of the Carnegie Mellon Human Relations Commission, the Department of Defense policy of "Don't ask, don't tell, don't pursue" excludes openly gay, lesbian and bisexual students from receiving ROTC scholarships or serving in the military. Nevertheless, all ROTC classes at Carnegie Mellon University are available to all students.

Inquiries concerning application of these statements should be directed to the Provost, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone (412) 268-6684 or the Vice President for Enrollment, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, telephone (412) 268-2056.

Obtain general information about Carnegie Mellon University by calling (412) 268-2000.

Interpreting Capability Maturity Model® Integration (CMMISM) for Operational Organizations

Brian P. Gallagher

April 2002

Technical Note
CMU/SEI-2002-TN-006

Software Engineering Process Management

Unlimited distribution subject to the copyright.

The Software Engineering Institute is a federally funded research and development center sponsored by the U.S. Department of Defense.

Copyright 2002 by Carnegie Mellon University.

NO WARRANTY

THIS CARNEGIE MELLON UNIVERSITY AND SOFTWARE ENGINEERING INSTITUTE MATERIAL IS FURNISHED ON AN "AS-IS" BASIS. CARNEGIE MELLON UNIVERSITY MAKES NO WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, AS TO ANY MATTER INCLUDING, BUT NOT LIMITED TO, WARRANTY OF FITNESS FOR PURPOSE OR MERCHANTABILITY, EXCLUSIVITY, OR RESULTS OBTAINED FROM USE OF THE MATERIAL. CARNEGIE MELLON UNIVERSITY DOES NOT MAKE ANY WARRANTY OF ANY KIND WITH RESPECT TO FREEDOM FROM PATENT, TRADEMARK, OR COPYRIGHT INFRINGEMENT.

Use of any trademarks in this report is not intended in any way to infringe on the rights of the trademark holder.

Internal use. Permission to reproduce this document and to prepare derivative works from this document for internal use is granted, provided the copyright and "No Warranty" statements are included with all reproductions and derivative works.

External use. Requests for permission to reproduce this document or prepare derivative works of this document for external and commercial use should be addressed to the SEI Licensing Agent.

This work was created in the performance of Federal Government Contract Number F19628-00-C-0003 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center. The Government of the United States has a royalty-free government-purpose license to use, duplicate, or disclose the work, in whole or in part and in any manner, and to have or permit others to do so, for government purposes pursuant to the copyright license under the clause at 252.227-7013.

For information about purchasing paper copies of SEI reports, please visit the publications portion of our Web site (<http://www.sei.cmu.edu/publications/pubweb.html>).

The following service marks and registered marks are used in this document:

Capability Maturity Model®

CMM®

CMMI™

CMM Integration™

CMM and Capability Maturity Model are registered in the U.S. Patent and Trademark Office.

CMMI and CMM Integration are service marks of Carnegie Mellon University.

Contents

Abstract.....	vii
1 Operational Organizations.....	1
2 CMMI for Product Development	2
3 CMMI for Operational Organizations.....	4
3.1 Mission Management.....	4
3.1.1 Task Planning	5
3.1.2 Task Monitoring and Control	5
3.1.3 Supplier Agreement Management.....	6
3.1.4 Integrated Mission Management.....	6
3.1.5 Operational Risk Management.....	7
3.1.6 Quantitative Mission Management	7
3.2 Mission Support.....	8
3.2.1 Configuration Management.....	8
3.2.2 Process and Mission Quality Assurance	9
3.2.3 Measurement and Analysis	9
3.2.4 Operational Readiness.....	10
3.2.5 Decision Analysis and Resolution	10
3.2.6 Causal Analysis and Resolution	11
3.3 Operational Process Management.....	11
3.3.1 Operational Process Focus	12
3.3.2 Operational Process Definition	12
3.3.3 Operational Training.....	12
3.3.4 Operational Process Performance	13
3.3.5 Operational Innovation and Deployment	13
3.4 Other Operational Considerations	14
4 Operational Process Improvement.....	15
5 Example – Fire Department.....	16
6 Example – Satellite Operations	18

7	Benefits for Development and Acquisition Organizations	20
8	Next Steps	22
	References.....	23

List of Figures

Figure 1: Fire Department Target Profile	17
Figure 2: Space Operations Target Profile.....	19
Figure 3: CMMI as the Common Framework	21

List of Tables

Table 1: Process Categories and Process Areas.....	2
Table 2: Capability Levels	3

Abstract

Capability Maturity Model[®] Integration (CMMISM) provides a framework for improving the processes organizations use to develop and deliver products for their customers. The process improvement concepts embedded in CMMI are based upon sound process management principles used in manufacturing communities for years. These principles have been successfully applied in software and systems engineering process improvement, and are codified for product development in CMMI. This technical note details how operational organizations that perform a variety of missions can benefit from the concepts in CMMI to improve the processes and effectiveness of mission operations.

[®] CMM and Capability Maturity Model are registered in the U.S. Patent and Trademark Office.
SM CMM Integration, and CMMI are service marks of Carnegie Mellon University.

1 Operational Organizations

An operational organization is any group of individuals teamed together to carry out a mission. A mission is a specific task or set of tasks with which a person or a group is charged to carry out. For the purpose of this technical note, an operational organization is considered to have mission elements or teams that carry out mission tasking or subsets of that tasking. These tasks could be either mission-essential tasks or mission-support tasks [USAF 2000].

Operational organizations and their mission elements or teams can be on the receiving end of products developed by engineering groups, or they may use less technical means to carry out their mission objectives. This broad definition of operational organizations includes entities such as military units, educational institutions, health care facilities, fire and police units, non-profit organizations, organizations that perform a service such as a help desk function, and even a “Meals on Wheels” operation.

Operational organizations, like engineering organizations, can benefit from a disciplined approach to improving their operational effectiveness. This effectiveness can be measured in terms of lower operating costs and higher throughput and yields on mission outcomes as well as improved working conditions and morale of operational personnel. When considering military units or emergency response teams, disciplined planning, execution, operational risk management, and continuous improvement could be critical to winning the war or saving lives.

With slight interpretations from an operational perspective, operational organizations can use CMMI models today to initiate and sustain an active operational process improvement program.

2 CMMI for Product Development

Engineering organizations improve their project management, support, process management, and engineering practices using CMMI models [SEI 2001]. These four categories are an affinity grouping of process areas which are, in turn, a collection of specific practices that industry experts agree are the characteristics of effective processes [see Table 1].

Category	Process Areas
Project Management	Project Planning Project Monitoring and Control Supplier Agreement Management Integrated Project Management Risk Management Quantitative Project Management
Support	Configuration Management Process and Product Quality Assurance Measurement and Analysis Causal Analysis and Resolution Decision Analysis and Resolution
Process Management	Organizational Process Focus Organizational Process Definition Organizational Training Organizational Process Performance Organizational Innovation and Deployment
Engineering	Requirements Management Requirements Development Technical Solution Product Integration Verification Validation

Table 1: Process Categories and Process Areas

Driven by their strategic business goals, organizations focus process improvement efforts on the areas critical to successfully delivering enhanced products to their customers. Thus, an Internet development organization may decide to focus on those process areas and practices within the model that could help them deliver products to the commercial marketplace quicker than a competitor. An organization building navigational or collision-avoidance systems for manned aircraft may be concerned with system quality and may choose areas of the model related to finding and removing product defects. Each of these organizations has different goals and objectives and therefore select the process areas in their CMMI model that best help them achieve their goals.

The engineering organization can use a CMMI model to raise the capability of process areas [see Table 2]. The characteristics that constitute a given capability level are captured in the generic practices of CMMI. A CMMI model provides guidance to help these engineering organizations through a proven approach to move from an ad hoc development process to one that values reasonable plans and processes that are developed, followed, measured, controlled, and eventually standardized, quantitatively managed, and continuously improved.

Level	Capability Levels
Level 0	Incomplete
Level 1	Performed
Level 2	Managed
Level 3	Defined
Level 4	Quantitatively Managed
Level 5	Optimizing

Table 2: Capability Levels

3 CMMI for Operational Organizations

Operational organizations can use these simple process-improvement concepts to improve their practices. Operational organizations contain mission elements or teams that do the following:

- plan their work
- carry out mission-essential and support tasks
- measure the effectiveness of their mission
- define operational procedures and processes
- control the configuration of these procedures and other work products
- identify and manage operational issues and risks
- make structured decisions
- continuously look for ways to improve mission effectiveness

On a very abstract level, an enlightened operational organization can use a CMMI model by thinking “mission task” instead of “project” and ignoring the engineering process areas. This approach would get it well on its way to using CMMI to improve operational processes and mission effectiveness. Of course, the devil is in the details so let’s look at how an operational organization might interpret each of the non-engineering process areas for its use.

3.1 Mission Management

The CMMI process area category called Project Management becomes Mission Management as an affinity grouping of those process areas that focus on improving the management of an operational mission. This process area category would contain the following process areas:

- Task Planning (Project Planning interpreted)
- Task Monitoring and Control (Project Monitoring and Control interpreted)
- Supplier Agreement Management (Supplier Agreement Management interpreted)
- Integrated Mission Management (Integrated Project Management interpreted)
- Operational Risk Management (Risk Management interpreted)
- Quantitative Mission Management (Quantitative Project Management interpreted)

Let’s interpret each of these process areas for an operational unit.

3.1.1 Task Planning

The purpose of Task Planning would be to establish and maintain plans that define mission-essential and support tasks or sub-tasks. Some operational organizations develop plans unique to each mission tasking they receive while others establish plans that are more global. The tasks performed may have discrete timelines or could be performed in a flow that is more continuous. Regardless of how the tasks are performed, this process area would be used to establish all levels of operational plans.

Task Planning would include the following specific goals (SGs) and specific practices (SPs):

SG 1 Establish Estimates

SP 1.1-1	Estimate the Scope of the Task
SP 1.2-1	Establish Estimates of Task Attributes
SP 1.3-1	Define the Task Timeline
SP 1.4-1	Determine Estimates of Effort and Cost

SG 2 Develop a Mission Plan

SP 2.1-1	Establish the Budget and Schedule
SP 2.2-1	Identify Operational Risks
SP 2.3-1	Plan for Data Management
SP 2.4-1	Plan for Task Resources
SP 2.5-1	Plan for Needed Knowledge and Skills
SP 2.6-1	Plan Stakeholder Involvement
SP 2.7-1	Establish the Task Plan

SG 3 Obtain Commitment to the Plan

SP 3.1-1	Review Plans that Affect the Task
SP 3.2-1	Reconcile Work and Resource Levels
SP 3.3-1	Obtain Plan Commitment

3.1.2 Task Monitoring and Control

The purpose of Task Monitoring and Control would be to provide an understanding of the task's progress so that appropriate corrective actions can be taken when the task's performance deviates significantly from the plan. Simply stated, operational leadership and personnel would monitor mission-essential and support task progress against plans and take appropriate actions if required.

Task Monitoring and Control would include the following specific goals and specific practices:

SG 1 Monitor Task Against Plan

- SP 1.1-1 Monitor Task Planning Parameters
- SP 1.2-1 Monitor Commitments
- SP 1.3-1 Monitor Operational Risks
- SP 1.4-1 Monitor Data Management
- SP 1.5-1 Monitor Stakeholder Involvement
- SP 1.6-1 Conduct Progress Reviews
- SP 1.7-1 Conduct Milestone Reviews

SG 2 Manage Corrective Action to Closure

- SP 2.1-1 Analyze Issues
- SP 2.2-1 Take Corrective Action
- SP 2.3-1 Manage Corrective Action

3.1.3 Supplier Agreement Management

The purpose of Supplier Agreement Management would be to manage the acquisition of materials and items from suppliers for which there exists a formal agreement. Operational organizations receive raw materials, supplies, and systems from external sources. This process area could be used by an operational organization to establish agreements with suppliers and ensure the agreements are mutually satisfied.

Supplier Agreement Management would include the following specific goals and specific practices:

SG 1 Establish Supplier Agreements

- SP 1.1-1 Determine Acquisition Type
- SP 1.2-1 Select Suppliers
- SP 1.3-1 Establish Supplier Agreements

SG 2 Satisfy Supplier Agreements

- SP 2.1-1 Review Commercial Source Opportunities and Risks
- SP 2.2-1 Execute the Supplier Agreement
- SP 2.3-1 Accept the Acquired Item
- SP 2.4-1 Transition Acquired Items into Operational Use

3.1.4 Integrated Mission Management

This process area would be an advanced Mission Management process area that an operational unit should take on after having a clear grasp of basic task planning and monitoring concepts. The purpose of Integrated Mission Management would be to establish, manage, and integrate mission-essential and support tasks and the involvement of relevant stakeholders according to an integrated and defined process that is tailored from the organization's set of standard processes. The concepts important to an operational unit are that task planning isn't reinvented for every new task and that missions are more effective when internal and external stakeholders are identified and managed.

Integrated Mission Management would include the following specific goals and specific practices:

SG 1 Use the Task's Defined Process

- SP 1.1-1 Establish the Task's Defined Process
- SP 1.2-1 Use Organizational Process Assets for Planning Task Activities
- SP 1.3-1 Integrate Mission Task Plans
- SP 1.4-1 Manage the Mission Tasks Using Integrated Plans
- SP 1.5-1 Contribute to the Organizational Process Assets

SG 2 Coordinate and Collaborate with Relevant Stakeholders

- SP 2.1-1 Manage Stakeholder Involvement
- SP 2.2-1 Manage Dependencies
- SP 2.3-1 Resolve Coordination Issues

3.1.5 Operational Risk Management

The purpose of Operational Risk Management would be to identify potential problems before they occur, so that risk-handling activities may be planned and invoked as needed across the mission tasks to mitigate adverse impacts on achieving mission objectives. Identifying and mitigating operational risks is critical to ensuring mission task effectiveness. In addition, operational risk identification and prioritization techniques could be used to justify or initiate the development or acquisition of new operational systems.

Operational Risk Management would include the following specific goals and specific practices:

SG 1 Prepare for Operational Risk Management

- SP 1.1-1 Determine Risk Sources and Categories
- SP 1.2-1 Define Risk Parameters
- SP 1.3-1 Establish an Operational Risk Management Strategy

SG 2 Identify and Analyze Operational Risks

- SP 2.1-1 Identify Operational Risks
- SP 2.2-1 Evaluate, Categorize, and Prioritize Risks

SG 3 Mitigate Operational Risks

- SP 3.1-1 Develop Operational Risk Mitigation Plans
- SP 3.2-1 Implement Operational Risk Mitigation Plans

3.1.6 Quantitative Mission Management

Quantitative Mission Management is an advanced Mission Management process area that would only be effective once an operational unit has a clear understanding of the capabilities of operational processes. The purpose of the Quantitative Mission Management process area would be to quantitatively manage the task's defined process to achieve the mission's established quality- and process-performance objectives. With a quantitative understanding of the operational organization's standard process for task execution, task planners can establish quantitative goals for a given task and manage the execution of the task using statistical process control techniques.

Quantitative Mission Management would include the following specific goals and specific practices:

SG 1 Quantitatively Manage the Mission

- SP 1.1-1 Establish the Task's Objectives
- SP 1.2-1 Compose the Task's Defined Process
- SP 1.3-1 Select the Subprocesses that Will Be Statistically Managed
- SP 1.4-1 Manage Task Performance

SG 2 Statistically Manage Subprocess Performance

- SP 2.1-1 Select Measures and Analytic Techniques
- SP 2.2-1 Apply Statistical Methods to Understand Variation
- SP 2.3-1 Monitor Performance of the Selected Subprocesses
- SP 2.4-1 Record Statistical Management Data

3.2 Mission Support

The CMMI process area category called Support becomes Mission Support as an affinity grouping of those process areas that focus on supporting the execution of mission-essential and support tasks. This process area category would contain the following process areas:

- Configuration Management (Configuration Management interpreted)
- Process and Mission Quality Assurance (Process and Product Quality Assurance interpreted)
- Measurement and Analysis (Measurement and Analysis interpreted)
- Operational Readiness (new process area)
- Decision Analysis and Resolution (Decision Analysis and Resolution interpreted)
- Causal Analysis and Resolution (Causal Analysis and Resolution interpreted)

Let's interpret each of these process areas for an operational unit.

3.2.1 Configuration Management

The purpose of Configuration Management would be to establish and maintain the integrity of operational work products using configuration identification, configuration control, configuration status accounting, and configuration audits. Mission task plans, system configurations, maintenance logs, drawings, raw materials, supplies, and training records would be just a few examples of the types of work products an operational unit would use this process area to manage.

Configuration Management would include the following specific goals and specific practices:

SG 1 Establish Baselines

- SP 1.1-1 Identify Configuration Items
- SP 1.2-1 Establish a Configuration Management System
- SP 1.3-1 Create or Release Baselines

SG 2 Track and Control Changes

- SP 2.1-1 Track Change Requests
- SP 2.2-1 Control Configuration Items

SG 3 Establish Integrity

- SP 3.1-1 Establish Configuration Management Records
- SP 3.2-1 Perform Configuration Audits

3.2.2 Process and Mission Quality Assurance

The purpose of Process and Mission Quality Assurance would be to provide operational staff and leadership with objective insight into operational processes and mission outcomes. An operational unit would continually assess the effectiveness of its operational processes and the outcome of performing mission tasks.

Process and Mission Quality Assurance would include the following specific goals and specific practices:

SG 1 Objectively Evaluate Operational Processes and Mission Outcomes

- SP 1.1-1 Objectively Evaluate Operational Processes
- SP 1.2-1 Objectively Evaluate Mission Outcomes

SG 2 Provide Objective Insight

- SP 2.1-1 Communicate and Ensure Resolution of Noncompliance Issues
- SP 2.2-1 Establish Records

3.2.3 Measurement and Analysis

The purpose of Measurement and Analysis would be to develop and sustain a measurement capability that is used to support information needs. An operational unit would align measurement activities with strategic plans and goals.

Measurement and Analysis would include the following specific goals and specific practices:

SG 1 Align Measurement and Analysis Activities

- SP 1.1-1 Establish Measurement Objectives
- SP 1.2-1 Specify Measures
- SP 1.3-1 Specify Data Collection and Storage Procedures
- SP 1.4-1 Specify Analysis Procedures

SG 2 Provide Measurement Results

- SP 2.1-1 Collect Measurement Data
- SP 2.2-1 Analyze Measurement Data
- SP 2.3-1 Store Data and Results
- SP 2.4-1 Communicate Results

3.2.4 Operational Readiness

The purpose of Operational Readiness would be to establish and maintain the readiness needs of operational systems and personnel. Operational Readiness would be a new process area to address the need to identify readiness levels, sustain inventories of required materials, and to maintain the readiness of operational systems and personnel.

Operational Readiness would include the following specific goals and specific practices:

SG 1 Establish Readiness Levels

- SP 1.1-1 Identify Critical Operational System Components and Personnel
- SP 1.2-1 Establish Readiness Levels for Critical Components and Personnel

SG 2 Establish Inventories for Critical Components

- SP 2.1-1 Establish Logistics Requirements and Sources
- SP 2.2-1 Maintain Inventories for Critical Components

SG 3 Maintain System and Personnel Readiness

- SP 3.1-1 Assess System and Personnel Readiness
- SP 3.2-1 Take Preventative and Corrective Action as Required

3.2.5 Decision Analysis and Resolution

The purpose of Decision Analysis and Resolution would be to analyze possible decisions using a formal evaluation process to evaluate identified alternatives against established criteria. Operational units are faced with a myriad of complex and critical decisions.

Operational personnel would benefit from having structured decision techniques to apply to a subset of these decisions.

Decision Analysis and Resolution would include the following specific goal and specific practices:

SG 1 Evaluate Alternatives

SP 1.1-1	Establish Guidelines for Decision Analysis
SP 1.2-1	Establish Evaluation Criteria
SP 1.3-1	Identify Alternatives
SP 1.4-1	Select Evaluation Methods
SP 1.5-1	Evaluate Alternatives
SP 1.6-1	Make Decisions

3.2.6 Causal Analysis and Resolution

Causal Analysis and Resolution is an advanced process area in the Mission Support category that is used once an operational unit has a detailed and quantitative understanding of problems and defects affecting their mission. The purpose of Causal Analysis and Resolution would be to identify causes of defects and other problems and take action to prevent them from occurring in the future. Preventing the future occurrence of problems and operational defects increases operational effectiveness and is a key capability in continuously improving operational processes.

Causal Analysis and Resolution would include the following specific goals and specific practices:

SG 1 Determine Causes of Mission Defects

SP 1.1-1	Select Mission Defect Data for Analysis
SP 1.2-1	Analyze Causes

SG 2 Address Causes of Mission Defects

SP 2.1-1	Implement Action Proposals
SP 2.2-1	Evaluate the Effect of Changes
SP 2.3-1	Record Data

3.3 Operational Process Management

The CMMI process area category called Process Management becomes Operational Process Management as an affinity grouping of those process areas that focus on standardizing and improving operational processes. This process area category would contain the following process areas:

- Operational Process Focus (Organizational Process Focus interpreted)
- Operational Process Definition (Organizational Process Definition interpreted)
- Operational Training (Organizational Training interpreted)
- Operational Process Performance (Organizational Process Performance interpreted)
- Operational Innovation and Deployment (Organizational Innovation and Deployment interpreted)

Let's interpret each of these process areas for an operational unit.

3.3.1 Operational Process Focus

The purpose of Operational Process Focus would be to plan and implement operational process improvement based on a thorough understanding of the current strengths and weaknesses of the operational organization's processes and process assets. Aligning improvement activities with operational needs eliminates the potential for sub-optimization based on misguided improvement activities.

Operational Process Focus would include the following specific goals and specific practices:

SG 1 Determine Process-Improvement Opportunities

- SP 1.1-1 Establish Operational Process Needs
- SP 1.2-1 Appraise the Operation's Processes
- SP 1.3-1 Identify the Operation's Process Improvements

SG 2 Plan and Implement Process-Improvement Activities

- SP 2.1-1 Establish Process Action Plans
- SP 2.2-1 Implement Process Action Plans
- SP 2.3-1 Deploy Operational Process Assets
- SP 2.4-1 Incorporate Process-Related Experiences into Operational Process Assets

3.3.2 Operational Process Definition

The purpose of Operational Process Definition would be to establish and maintain a usable set of operational process assets. Codifying the expected behavior of mission elements and teams based on operational needs begins to establish an experience factory within the operational organization.

Operational Process Definition would include the following specific goal and specific practices:

SG 1 Establish Operational Process Assets

- SP 1.1-1 Establish Standard Processes
- SP 1.2-1 Establish Task Timeline Descriptions
- SP 1.3-1 Establish Tailoring Criteria and Guidelines
- SP 1.4-1 Establish the Operation's Measurement Repository
- SP 1.5-1 Establish the Operation's Process Asset Library

3.3.3 Operational Training

The purpose of Operational Training would be to develop the skills and knowledge of people so they can perform their roles effectively and efficiently. Operational Training includes training to support the operational organization's strategic objectives and to meet the tactical training needs that are common across mission elements and teams.

Operational Training would include the following specific goals and specific practices:

SG 1 Establish an Operational Training Capability

- SP 1.1-1 Establish Strategic Training Needs
- SP 1.2-1 Determine Which Training Needs Are the Responsibility of the Operational Organization
- SP 1.3-1 Establish an Operational Training Tactical Plan
- SP 1.4-1 Establish Training Capability

SG 2 Provide Necessary Training

- SP 2.1-1 Deliver Training
- SP 2.2-1 Establish Training Records
- SP 2.3-1 Assess Training Effectiveness

3.3.4 Operational Process Performance

Operational Process Performance is an advanced process area that helps an operational organization gain a quantitative understanding of the performance of selected operational processes or subprocesses. The purpose of Operational Process Performance would be to establish and maintain a quantitative understanding of the performance of the operation's set of standard processes in support of quality- and process-performance objectives, and to provide the process performance data, baselines, and models to quantitatively manage the operation's mission-essential and support tasks.

Operational Process Performance would include the following specific goal and specific practices:

SG 1 Establish Performance Baselines and Models

- SP 1.1-1 Select Processes
- SP 1.2-1 Establish Process Performance Measures
- SP 1.3-1 Establish Quality- and Process-Performance Objectives
- SP 1.4-1 Establish Process Performance Baselines
- SP 1.5-1 Establish Process Performance Models

3.3.5 Operational Innovation and Deployment

Operational Innovation and Deployment is an advanced process area that builds on an operation's quantitative understanding of its process performance and incorporates incremental and innovative changes to meet operational objectives. The purpose of Operational Innovation and Deployment would be to select and deploy incremental and innovative improvements that measurably improve the operation's processes and technologies.

Operational Innovation and Deployment would include the following specific goals and specific practices:

SG 1 Select Improvements

- SP 1.1-1 Collect and Analyze Improvement Proposals
- SP 1.2-1 Identify and Analyze Innovations
- SP 1.3-1 Pilot Improvements
- SP 1.4-1 Select Improvements for Deployment

SG 2 Deploy Improvements

- SP 2.1-1 Plan the Deployment
- SP 2.2-1 Manage the Deployment
- SP 2.3-1 Measure Improvement Effects

3.4 Other Operational Considerations

The above interpretation is one view of how an operational organization might approach using CMMI to improve operational processes and mission effectiveness. Obviously, every operational organization must consider additional areas that are critical to the successful completion of its mission-essential and support tasks. Many operational organizations receive their tasking from external sources such as a higher command authority or from customer requests. In this case, the Engineering process area, Requirements Management, could be used to address the need to manage external tasking. Some may find the areas of safety or security important enough to construct process areas to help guide their improvement efforts. The operational organization would also identify additional process needs as it raised the capability of its operational processes.

4 Operational Process Improvement

Starting an operational process-improvement program is much like starting any generic improvement effort. The first step in improving something is to understand the boundaries of the “system” you are trying to improve. The “system” could be an assembly line, a business unit, an engineering organization, or any combination of people, tools, technologies, and methods employed to accomplish a task. In the case of an operational organization, that “system” could, for example, be a fighter wing, a space operations squadron, a fire department, or a university.

Once the operational entity is defined, a clear understanding of the operational entity’s purpose and objectives guides improvement efforts. Many times, the purpose and objectives are stated in strategic planning documents. A clear understanding of the purpose and objectives will keep improvement efforts aligned with strategic needs and will avoid expending critical resources on improvement efforts that don’t contribute to those needs.

Along with understanding the operational entity’s objectives, it’s important to understand how to know if you achieve its objectives. It sounds good to say you intend to make your operation “world class,” but how would you know when you’re there? The objectives of an operational entity should be stated so that you can perform some level of verification to confirm that your improvement efforts move you closer to those objectives.

Once the operational entity requiring improvement is identified and its purpose is clearly understood, constraints and risks are more easily identified and addressed. The current state of the operational entity could be assessed against its objectives to identify current and potential barriers to meeting those objectives. Improvement plans would then be developed and implemented to address these barriers.

Operational process improvement using a CMMI model is simply an organized approach to identifying and addressing these constraints and risks and helping the operational entity more effectively achieve its purpose.

5 Example – Fire Department

Most metropolitan areas have a fire department. Typically, a fire department will have teams of fire and emergency personnel working 24-hour shifts to fight fires and respond to numerous emergency situations.

In this example, the operational entity is such a fire department. Its purpose would be stated in a mission statement such as:

The Fire Department protects the life and property of city residents and visitors from fire and critical health threats by doing the following:

- *fighting fires to save life and property*
- *providing pre-hospital emergency medical service*
- *investigating the causes and origins of fires*
- *regulating public safety*
- *conducting fire safety presentations and events*

The objectives for the fire department would answer questions such as the following:

- How quickly must emergency vehicles and teams respond to fight a fire?
- What is the quality of the pre-hospital emergency medical service provided?
- How quickly and accurately can the cause and origin of a fire be determined?
- How often are safety codes violated?
- How effective are fire prevention activities?

Mission-essential tasks might include fighting fires, providing emergency medical service, and investigating causes and origins of fires. Mission-support tasks might include regulating public safety and conducting fire prevention activities.

Based on the purpose of this fire department and its stated objectives and tasks, leaders within the fire department chain of command would prioritize areas most important to the accomplishment of the fire department's mission and identify areas as candidates for focused improvement efforts. For example, the fire department may consider mission-essential and support task planning and cause and origin of fire determination most important. Maintaining the readiness levels of equipment and personnel might also be an imperative. The fire department has many vendors who supply critical equipment and supplies and management of these vendors is a high priority. In addition, because of high turnover due to an early retirement program, training new fire and emergency personnel could be of concern.

Using CMMI, this fire department might select the following process areas as the most important ones to improve first:

- Task Planning (TP)
- Task Monitoring and Control (TMC)
- Operational Training (OT)
- Operational Readiness (OR)
- Causal Analysis and Resolution (CAR)
- Supplier Agreement Management (SAM)

They could then develop a “target profile” of these process areas, which includes the capability level they feel they need to attain in each process area to attain future success (see Figure 1).

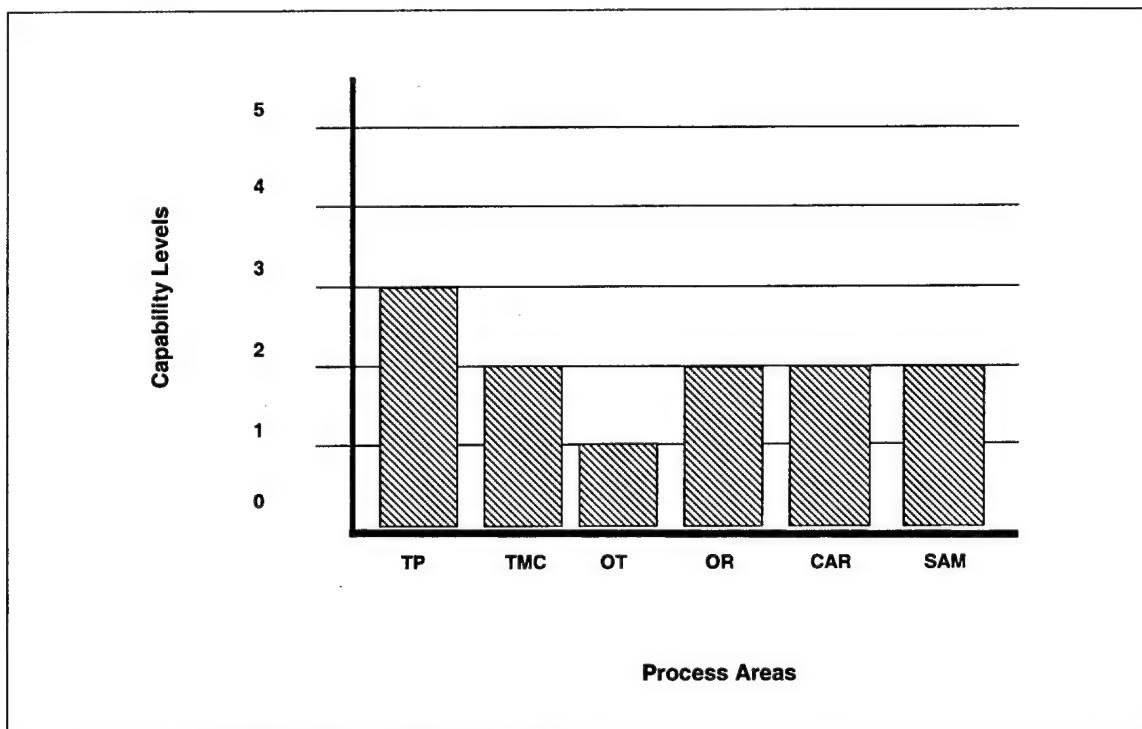


Figure 1: Fire Department Target Profile

With the scope, purpose, and objectives of the fire department defined, and a prioritized list of areas deemed critical to its success identified, the fire department can perform a simple and informal gap analysis between CMMI practices and the department’s implemented processes. The constraints, weaknesses, and risks identified become the areas the department can address to improve their practices. As the fire department implements improvements, they will learn from the experience and cycle through another phase of improvement based on what they learned.

6 Example – Satellite Operations

In the US Air Force there are operational units responsible for operating critical satellite systems. Typically, a space-operations squadron would have teams of airmen and contractor personnel who work shifts performing 24-hour satellite tasking, operations, front-line maintenance, and support for the purpose of carrying out the squadron's mission.

In this example, the operational entity is the space-operations squadron. Its purpose would be stated in a mission statement such as the following:

Perform accurate and timely detection of worldwide ballistic missile launches and nuclear detonations by doing the following:

- *processing satellite information*
- *performing satellite command and control functions*
- *monitoring and maintaining data processing equipment*
- *preparing for initial operations of a new sensor*

The objectives for this squadron would answer questions such as the following:

- How quickly and accurately must the system process satellite information?
- How reliably must operational systems perform control functions?
- How quickly must data processing equipment problems be identified and corrected?
- When would we know we were prepared for operating a new sensor?

Mission-essential tasks might include processing satellite information and performing satellite command and control functions. Mission-support tasks might include monitoring and maintaining data processing equipment and preparation activities to operate the new sensor.

Based on the purpose of this squadron, its stated objectives and tasks, leaders within the Air Force would prioritize areas most important to the accomplishment of the squadron's mission and identify areas as candidates for focused improvement efforts. For example, the squadron may consider mission-essential task planning and sensor tasking most important. Maintaining the readiness levels of equipment and personnel might also be an imperative. In addition, because they will operate a new sensor in the near future, an aggressive training program and risk identification process could be of concern.

Using CMMI, this squadron might select the following process areas as the most important ones to improve first:

- Task Planning (TP)
- Task Monitoring and Control (TMC)
- Integrated Mission Management (IMM)
- Operational Training (OT)
- Operational Readiness (OR)
- Operational Risk Management (ORM)

They could then develop a “target profile” of these process areas, which includes the capability level they feel they need to attain in each process area to attain future success (see Figure 2).

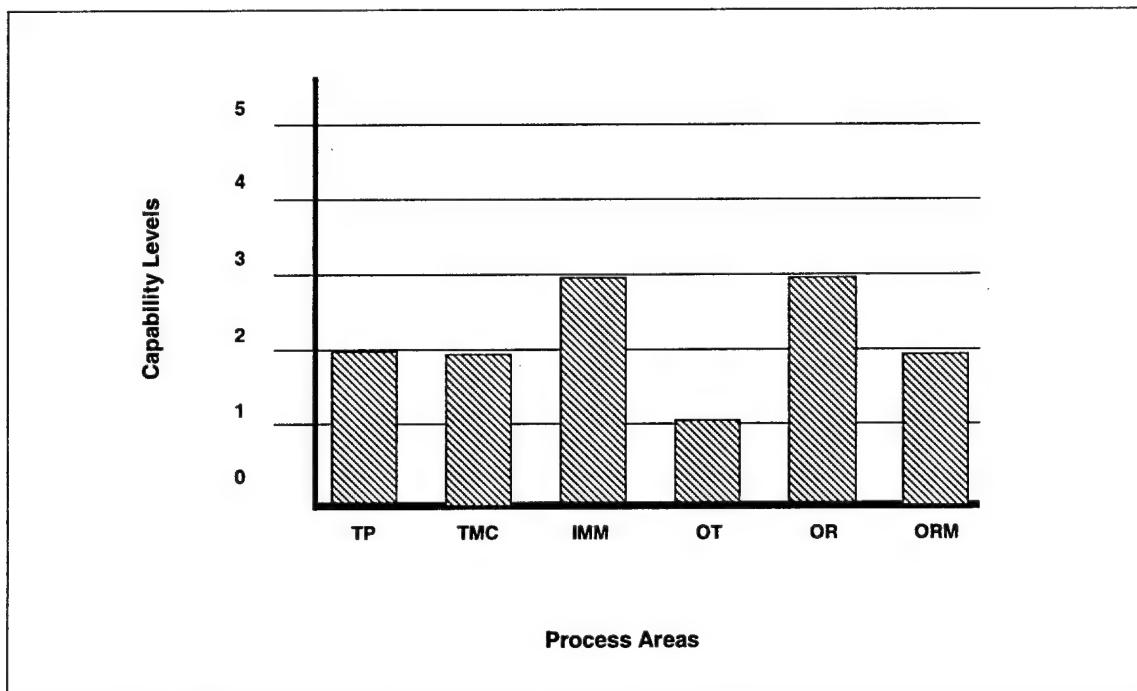


Figure 2: Space Operations Target Profile

With the scope, purpose, and objectives of the space operations squadron defined, and a prioritized list of areas deemed critical to its success identified, the squadron can perform a simple and informal gap analysis between CMMI practices and the squadron’s implemented processes. The constraints, weaknesses, and risks identified become the areas the squadron can address to improve their practices. As the operational squadron implements improvements, they will learn from the experience and cycle through another phase of improvement based on what they learned. This is why it’s called *continuous process improvement*.

7 Benefits for Development and Acquisition Organizations

Product development organizations are aligning and improving their engineering practices using CMMI. The model provides a common language and focus for improvement across all the disciplines that team together to build and deliver products. Acquisition organizations that commission a developer and oversee that developer building and delivering products are beginning to use CMMI to increase the probability of success when teaming with a developer to bring enhanced capabilities to operational organizations.

One of the most difficult acquisition and development tasks is to shift new capabilities into operational use. After years of development, new systems fail to meet an operational need or to mitigate an operational risk. Resistance comes from operators who see a depletion of capability or are forced to change their operational processes to meet awkward business models built into the new product. The DoD is attempting to address this problem by encouraging their acquisition organizations to adopt evolutionary acquisition practices. DoD Directive 5000.1, *The Defense Acquisition System*, states:

4.2.2. Time-Phased Requirements and Communications with Users.

Validated time-phased requirements generation is an evolutionary approach to specifying operational requirements in an incremental manner over time matched with projected threat assessments and available technology. Time-phased requirements are essential to evolutionary acquisition strategies and are strongly encouraged as a preferred approach to establishing and documenting operational needs. The Defense acquisition and requirements communities shall maintain continuous and effective communications with each other and with the operational user. The objective is to gain a sound understanding of the users' needs and to work with them to achieve a proper balance among cost, schedule, and performance considerations.

Unfortunately, not much guidance is available on how to successfully “communicate with each other” to acquire, develop, and deliver capabilities to users in an evolutionary fashion. Delivering the wrong system faster won’t solve an operational need. The practices used by the acquirer, developer, and operator need to be well defined, understood, and aligned with mission objectives so that operational deficiencies and risks can be clearly stated and new systems built to address these clearly stated needs.

Figure 2 shows how the success of each organization depends on close cooperation and communication with the others. The ideal environment for incremental or evolutionary

delivery of systems into operational use would include acquirers, developers, and operators, all using a common framework to plan, manage, make decisions, manage and communicate issues and risks, define and improve processes, and work effectively in cross-organizational teams.

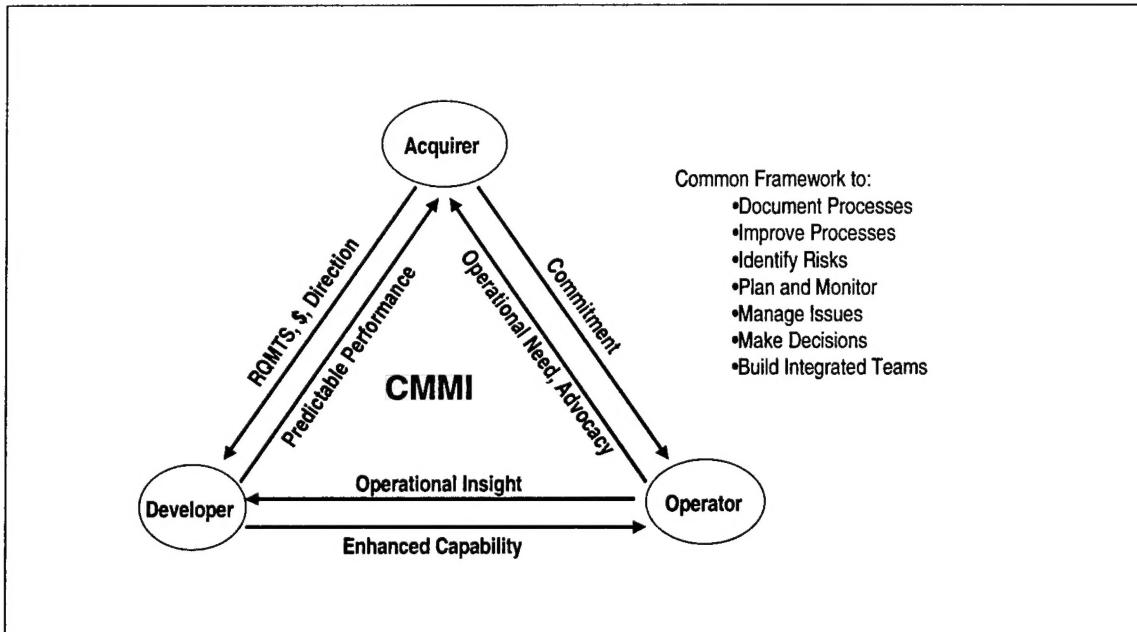


Figure 3: CMMI as the Common Framework

As operational organizations are challenged with needing new and innovative technologies to meet evolving threats, the need for disciplined practices and a common language for improvement shared with their suppliers is greater than ever. CMMI provides the basis for such a vision.

8 Next Steps

This is the first attempt to show how an operational organization can interpret CMMI to help establish and maintain an operational process-improvement program. An enlightened leader within an operational organization could start a CMMI-based improvement program today without further model definition. Others may take these ideas and further refine them and propose an addition to the CMMI model framework that explicitly addresses operational needs.

References

[SEI 2001] CMMI Product Development Team. *Capability Maturity Model Integration (CMMI)*, Version 1.1 (CMU/SEI-2002-TR-001), Pittsburgh, PA. Software Engineering Institute, Carnegie Mellon University, December 2001
<http://www-preview.sei.cmu.edu/publications/documents/02.reports/02tr001.html>.

[USAF 2000] United States Air Force, Air Force Instruction 90-1102. *Performance Management*, afpubs.hq.af.mil/pubfiles/af/90/afi90-1102/afi90-1102.pdf, February 2000.

[DoD 2000] Office of the Secretary of Defense, Department of Defense Directive 5000.1, *The Defense Acquisition System*, www.acq.osd.mil/ar/#5000, October 2000.

REPORT DOCUMENTATION PAGE		<i>Form Approved OMB No. 0704-0188</i>	
<p>Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.</p>			
1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE February 2002	3. REPORT TYPE AND DATES COVERED Final	
4. TITLE AND SUBTITLE Interpreting Capability Maturity Model® Integration (CMMI SM) for Operational Organizations		5. FUNDING NUMBERS F19628-00-C-0003	
6. AUTHOR(S) Brian Gallagher			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Software Engineering Institute Carnegie Mellon University Pittsburgh, PA 15213		8. PERFORMING ORGANIZATION REPORT NUMBER CMU/SEI-2002-TN-006	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) HQ ESC/XPK 5 Eglin Street Hanscom AFB, MA 01731-2116		10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES			
12A DISTRIBUTION/AVAILABILITY STATEMENT Unclassified/Unlimited, DTIC, NTIS		12B DISTRIBUTION CODE	
13. ABSTRACT (MAXIMUM 200 WORDS) Capability Maturity Model® Integration (CMMI SM) provides a framework for improving the processes organizations use to develop and deliver products for their customers. The process improvement concepts embedded in CMMI are based upon sound process management principles used in manufacturing communities for years. These principles have been successfully applied in software and systems engineering process improvement, and are codified for product development in CMMI. This technical note details how operational organizations that perform a variety of missions can benefit from the concepts in CMMI to improve the processes and effectiveness of mission operations.			
14. SUBJECT TERMS CMMI, process improvement, operational organization		15. NUMBER OF PAGES 35	
16. PRICE CODE			
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89) Prescribed by ANSI Std. Z39-18 298-102

[®] CMM and Capability Maturity Model are registered in the U.S. Patent and Trademark Office.
SM CMM Integration, and CMMI are service marks of Carnegie Mellon University.